EFFECT OF SOME NATURAL ANTIOXIDANT SOURCES ON OXIDATIVE STABILITY OF EGG POWDER DURING STORAGE

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ABSTRACT
This study was designed to evaluate the effect of some natural antioxidant (NA) sources (turmeric, ginger and clove) on the oxidative stability of whole egg powder stored over a period of 90 days. A total of one hundred and twenty (120) eggs were freshly purchased from a reputable farm and allotted into four (4) groups with same mean weight and size. Each group had three (3) replicate containing 10 eggs per replicate. Eggs in the various treatment groups were treated with; 0g/kg of natural antioxidant, 2.00g/kg of ginger, 2.00g/kg of turmeric and 2.00g/kg of clove, in a completely randomized design (CRD). Fresh whole eggs (yolk and albumen) treated with natural sources of antioxidants were homogenized and dehydrated at 65°C for 19 hours using a thermostat oven, the dried eggs were allowed to cool before it was blended, weighed, sieved and packaged using an air-tight container in an aseptic condition. The samples were evaluated over a period of three (3) month in the laboratory for oxidative stability (Malondialdehyde (MDA), superoxide dismutase (SOD), catalase (CAT), and glutathione (GSH). Data generated was subjected to analysis of variance using SAS and differences in treatment means were separated using Fisher's LSD method. From the result obtained, oxidative parameters measured had no significant (p>0.05) difference across treatment groups. Turmeric treated egg powder at 2g/kg demonstrated superior antioxidant properties during the 90 Days storage period. Ginger treated egg powder was more effective in lipid peroxidation.
Keywords: Egg powder, Malondialdehyde, Superoxide dismutase, Catalase, Glutathione

INTRODUCTION

Nigeria has an average rate of egg consumption of approximately 78.48 eggs per person/annum (FAO, 2022; USDA, 2022) which is below the World Health Organization recommended minimum standard and it is the most affordable animal protein in Nigeria. PAN (2018); reported that Nigeria is one of the highest egg producers in Africa with 10.3 billion eggs produced in a year; The short shelf life of eggs and the tendency for individuals to consume fewer eggs between February and May result in an annual glut for Nigerian poultry farmers. Fresh eggs are difficult to transport because of their size, breakability, and highly spoilable nature (Jay, 2000). Inadequate processing and storage facilities cause Nigerian egg producers and marketers to lose a great deal of money due to spoilage.

The need for adequate processing to increase shelf life for better storage and transportation is imperative. However, the nation's poultry farmers have not yet completely tapped into the vast production potential of eggs by processing them into powder, dry, frozen, salted, sugared, pasteurized, cooked, and other forms, increasing its shelf life and ensuring food safety. Poultry eggs are rich in nutrient and are a great source of protein; therefore, adequate processing and utilization of eggs will lead to an increase in the protein intake in Nigeria. Studies have shown that dried powdered eggs solve the problem of bulkiness, easily breakable nature of fresh eggs and the storage challenges, and under optimal storage conditions it is possible to store eggs for a year or beyond (Jay, 2000).

According to Tanvir *et al*., (2017), antioxidants prevent oxidative damage through one-electron reactions with free radicals [superoxide radicals ($O2^{\cdot-}$), hydroxylradicals ($OH^{\cdot}$), singlet oxygen ($O^{\cdot}$), and hydrogen peroxide($H2O2$)] that adversely alter cellular lipids, protein, DNA, and polysaccharides [1, 2]. Therefore, a balance between free radical and antioxidant concentrations is necessary to maintain proper physiological functions. Antioxidants in the form of commercial food additives have been manufactured synthetically and may contain high amounts of preservatives. Some synthetic antioxidants, such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and tertiary butyl hydroquinone (TBHQ), have been reported to produce toxins or act as carcinogens. Therefore, identifying that potential natural antioxidant sources such as clove, ginger and turmeric, can be a useful alternative to ensure sound health.

This study was therefore designed to determine the effect of some natural sources of antioxidant (clove, ginger and turmeric) on the oxidative stability of whole egg powder over a storage duration of 90 days.

MATERIALS AND METHODS

The study was carried out at the Animal Science Laboratory, Kaduna State University, Kafanchan Campus, Kaduna State. Kafanchan is located at latitude 9°59'N, longitude 8°29'E and it is situated at an elevation of 733m above sea level (Gandi *et al*., 2020).

A total of 120 eggs were evenly allotted into four treatment groups with three replicates of 10 eggs each and randomly treated with: 0g/kg of natural sources of antioxidant (EP), 2.00g/kg of turmeric (TTEP), 2.00g/kg of ginger (GTEP), and 2.00g/kg of clove (CTEP). Whole eggs and treatments were emptied into a container, homogenized and dehydrated at 65°C for 19 hours, the dry brittle egg was allowed to cool and then packed from the tray into a cleaned dry blender, and blended into powder, sieved and weighed. Egg powder was packaged in plastic airtight containers. All procedures were carried out aseptically.

Egg powder samples were labelled and analyzed over a period of 90 days (Day 1, 45 and 90) at the Clinical Pathology Laboratory, National Veterinary Research Institute (NVRI) Jos, to determine the oxidative stability following procedures of Beutler *et al*., (1963) and Varshney and Kale (1990).

The experiment was designed as a 4 × 3 factorial arrangement in a completely randomized design. Data collected was subjected to Analysis of Variance (ANOVA) using the general linear model of SAS (2002), while differences in treatment means were separated using Fisher's LSD method.

RESULTS AND DISCUSSION

The results of the effect of some natural antioxidant sources (ginger, turmeric and clove powder) on oxidative stability of whole egg powders are shown in Table 1. Results from the four (4) samples: 0g/kg of natural antioxidant (EP), Ginger treated Egg Powder (GTEP), Turmeric treated Egg Powder (TTEP) and Clove treated Egg Powder (CTEP), showed that the values were significantly different ($p<0.05$) across treatment groups for MDA. Ginger treated egg powder showed the lowest ($p<0.05$) MDA level (2.09 mmol/mg), indicating strong inhibition of lipid peroxidation. Egg powder treated with 0g/kg of natural sources of antioxidant and TTEP had statistically ($p>0.05$) same values for MDA, but were however similar to values recorded for CTEP which had the highest value (3.78mmol/mg). The control sample (EP) was better (3.23 mmol/mg) compared to CTEP (3.78 mmol/mg) but less effective than TTEP and GTEP. Superoxide Dismutase (SOD) showed that there was no significant difference ($p>0.05$) between treatment groups. Gulcin *et al*.; (2012) reported that clove contains eugenol which enhances enzymatic antioxidant defence same as SOD and CAT, suggesting that clove may have improved enzymatic antioxidant defence. Ginger treated whole egg powder (GTEP) and TTEP showed lower SOD activity, indicating less stimulation of this enzyme, possibly due to direct scavenging of superoxide radicals by the added antioxidants as stated by Rahmani *et al*., (2014).

Catalase showed in the results that there was no significant difference ($p>0.05$) across treatment groups of CAT values. Ginger treated egg powder had the highest (15.99 µmole/mg) numeric value for CAT activity, closely followed by CTEP (15.54 µmole/mg), but not statistically different. This may suggest that ginger offered at higher concentrations can enhance the breakdown of hydrogen peroxide. Turmeric treated egg powder value for CAT activity (14.12 µmole/mg) agrees with a report by Jayaprakasha *et al*.; (2006) that turmeric's curcuminoids exhibited potent antioxidant properties by neutralizing free radicals and enhancing endogenous antioxidant systems.

High GSH shows enhanced cell's ability to neutralize oxygen species (ROS), reducing oxidative stress (Lu *et al*., 2013) while decreased GSH increases oxidative stress as recorded by Townsend *et al*.; (2003). The results obtained showed that the values were not significantly different ($p<0.05$). Clove treated whole egg powder had a mean value of 4.70µg/ml, suggesting less effectiveness of clove in boosting cellular antioxidant capacity. Ginger treated whole egg powder recorded 5.38 µmole/mg GSH level, consistent with its role in maintaining intracellular redox balance.

The oxidative stability result for treated whole egg powder as affected by storage duration shows that the values obtained across storage durations (Day 1, Day 45 and Day 90) were significantly different ($p<0.05$) for MDA. Malondialdehyde values decreased over time, from 3.31 mmol/mg to 2.59 mmol/mg. Superoxide dismutase (SOD) showed that there was no significant difference ($p>0.05$) across storage interval of SOD values. Activity of SOD declined at Day 90 (13.66 µmole), showing enzyme degradation over time or reduced oxidative stress indicating less SOD activity.

The values obtained for CAT as a measure of natural source of antioxidant were significantly different ($p<0.05$) across storage durations. Catalase increased over time reaching its peak (16.14 µmole/mg) at Day 90, this could be a compensatory response to prolonged exposure to oxidative conditions.

Glutathione (GSH) values showed that there was no statistically significant difference ($p>0.05$) across storage intervals. Glutathione (GSH) levels had a value of 5.36 µg/ml at Day 45 but declined (4.90 µg/ml) at Day 90, this agrees with a study by Srinivasan (2014) who reported antioxidant activity diminishing with prolonged storage due to degradation of natural antioxidants.

The interaction between natural sources of antioxidant and storage duration was not statistically significant ($p>0.05$) for any parameter, suggesting that the main effects of natural sources of antioxidant and storage duration independently influence oxidative stability.

Table 1: Effect of Natural Sources of Antioxidant and Storage Duration on Oxidative Stability of whole Egg Powders

Parameters	MDA (mmol/mg)	SOD (µmole)	CAT (µmole/mg)	GSH (µg/ml)
Treatment				
EP	3.23^{ab}	19.33	15.25	5.27
GTEP	2.09^{a}	18.41	15.99	5.38
TTEP	2.61^{ab}	17.99	14.12	5.09
CTEP	3.78^{b}	20.17	15.54	4.70
LSD	1.65	3.47	3.07	0.98
Storage Duration				
Day 1	3.31	21.56^{a}	13.69^{a}	5.07
Day 45	2.89	21.71^{b}	15.84^{ab}	5.36
Day 90	2.59	13.66^{a}	16.14^{b}	4.90
LSD	1.34	2.88	2.29	0.76
Interaction				
T*S	0.85^{NS}	0.38^{NS}	0.76^{NS}	0.66^{NS}

ab: the values marked with different letters vary significantly ($P<0.05$) across the column, MDA: Malondialdehyde, GSH: Glutathione, SOD: Superoxide Dismutase, LSD: Least significant difference, EP: 0g/kg of natural antioxidant, GTEP: 2g/kg of ginger, TTEP: 2g/kg of turmeric, CTEP: 2g/kg of clove

CONCLUSION

Natural antioxidant sources (ginger, turmeric and clove) improved oxidative stability of the whole egg powder during storage. Turmeric treated egg powder had superior antioxidant properties during the three (3) months of storage.

RECOMMENDATION

Turmeric is recommended to improve egg powder oxidative stability and further studies on clove's potential, combinations of antioxidants and the use of its extract are recommended.

REFERENCES

Beutler, E., Duron, O. and Kelly, B. M. (1963). Improved method for the determination of blood glutathione. *The Journal of Laboratory and Clinical Medicine*, 61(5), 882-888.

FAO. (2022). Global egg production and consumption trends. FAO Annual Report. Retrieved from https://www.fao.org.

Gandi, B. R., Jibri, M., Abdu, S. B. and Duru, S. (2020). Evaluation of poultry by-product meal treated with ginger (*Zingiber officinale* (L) Rosc). *Nigerian Journal of Animal Production, 2020, 47(2):68 – 75.*

Gulcin, I., Elias, R. and Haque, M. (2012). Bioactive properties of clove and turmeric: Implications for antioxidant strategies. *Journal of Agricultural Sciences*, 19(5), 45-57.

Jayaprakasha, G. K., Rao, L. J. and Sakariah, K. K. (2006). Antioxidant activities of curcumin and its role in lipid oxidation. *Molecular Nutrition and Food Research*, 50(1), 44-51.

Jay, M. J. (2000). Modern Food Microbiology. 6th ed. *Aspen Publishers Inc.*,Gaithersburg, Maryland.

Lu, S. C., Huang, W. H. and Chen, C. J. (2013). Role of glutathione in antioxidant defense mechanisms. Antioxidants & Redox Signaling, 19(7), 1016-1031.

PAN (2018). The Bureau of Public Enterprises (BPE) and the Biz Quote Of The Day. Poultry Association of Nigeria (PAN).

Rahmani, A. H., Al Shabrmi, F. M. and Aly, S. M. (2014). Active ingredients of ginger as potential candidates in prevention and treatment of diseases via modulation of biological activities. *International Journal of Physiology, Pathophysiology and Pharmacology*, 6(2): 125-136.

Srinivasan, K. (2014). Nutritional profile of spices and their potential health benefits. *Journal of Medicinal Food*, 17(1), 1-13.

Tanvir, E., Fuad, H. and Sakib, H. (2017). Antioxidant Properties of Popular Turmeric (*Curcuma longa*) Varieties from Bangladesh. *Journal of Food Quality* Volume 2017, Article ID8471785, 8 pages.

Townsend, D. M., Tew, K. D. and Tapiero, H. (2003). Glutathione and glutathione-dependent enzymes in oxidative stress. Biomedicine & Pharmacotherapy, 57(3-4), 145-155.

USDA (2000). United States Department of Agriculture-Agricultural Marketing Service. Egg Grading Manual. Agricultural Handbook Number 75. USDA-AMS-Poultry Programs STOP 0259 1400 Independence Avenue, SW, Washington, DC 20250-0259.

Varshney, R. and Kale, R. (1990). Effects of oxidative stress on catalase activity. Journal of Biochemistry and Biophysics, 12(2), 65-72.